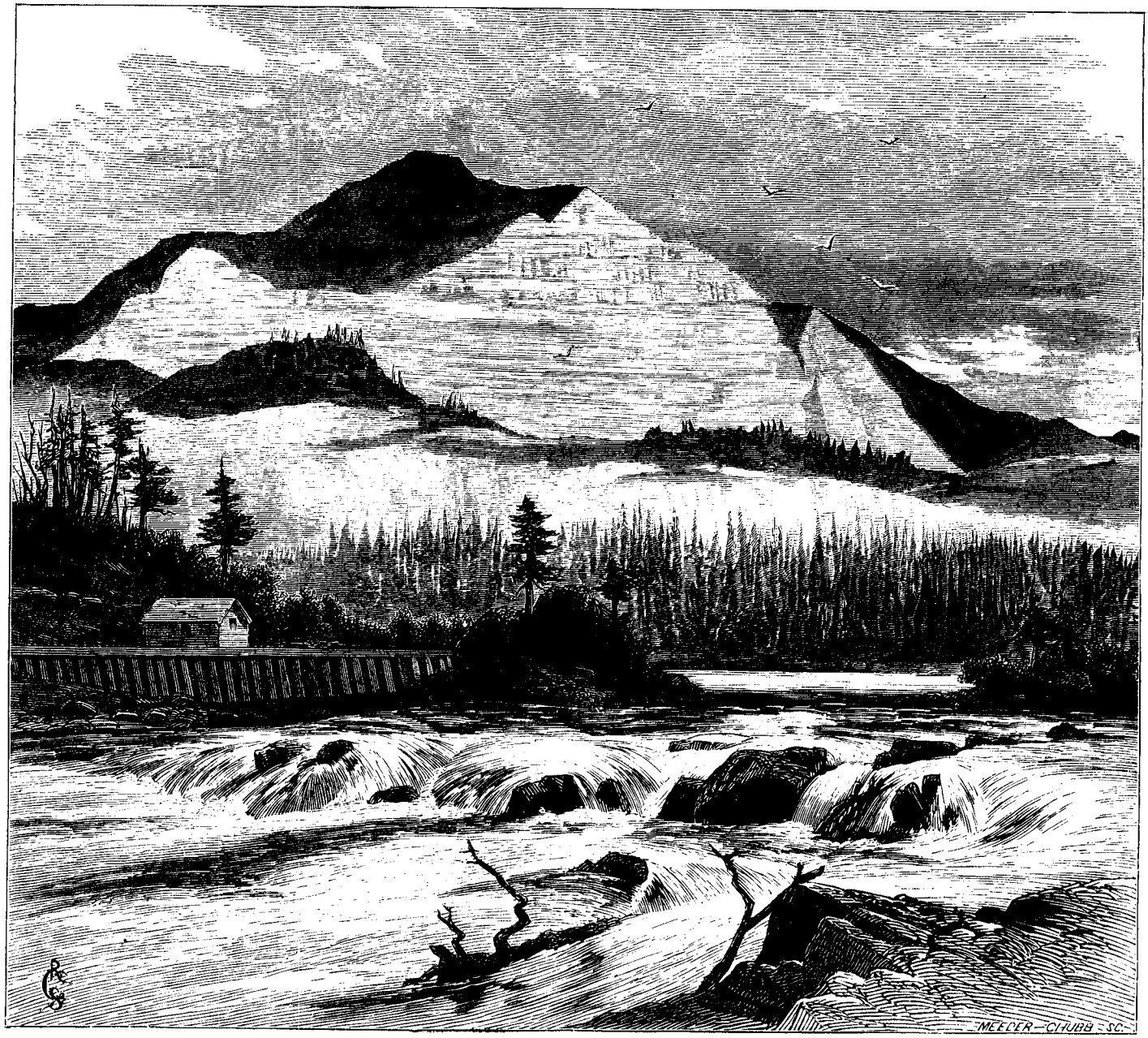


Swain Gifford woodcut depicting the Cascades Rapid.

Chapter 3 The Cascades Canel and Permanent River and Harbor Improvements

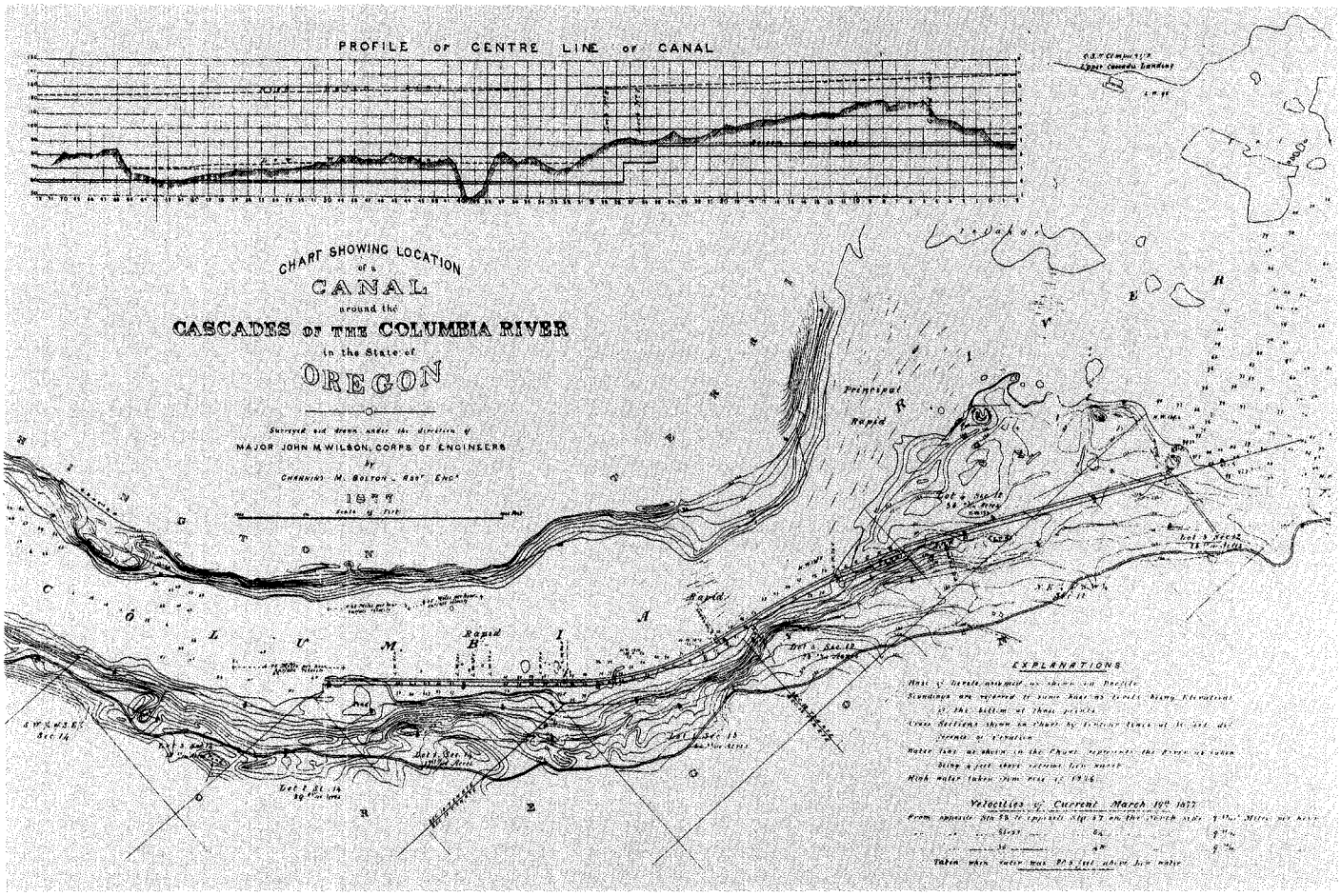
Cascades Canal Project

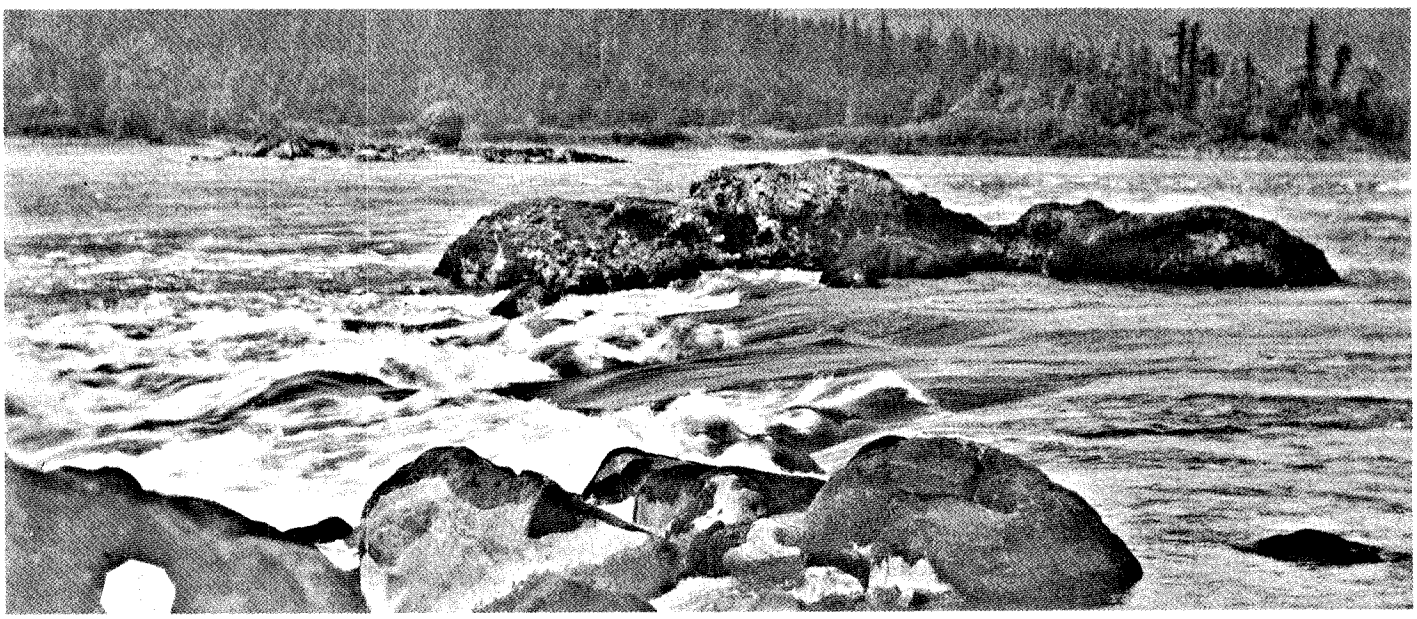
The most important project undertaken during Major Wilson's tenure was the beginning of the canal around the Cascades on the Columbia River. The Cascades were located a few miles upstream from where Bonneville Dam now stands. Noting in 1876 that falls at The Dalles and the Cascades interrupted navigation of the Columbia, Major Wilson felt that "the interests of this great and rapidly-developing portion of our country will demand the construction of canals around these obstacles . . . for the route via the Columbia and Snake Rivers is the only one by which the products, not only of Eastern Oregon but also of a large portion of the Territories of Washington and Idaho, can be brought into market."[1]

From the days when traffic on the river first appeared, means had to be devised to transport people and goods past the barrier presented by Cascade Rapids. The earliest methods consisted of a one-mule outfit built in 1851 and placed in operation on the Washington Territory side of the river. For 75 cents, 100 pounds of "emigrants effects" could be portaged safely around the rapids. Additional mules and cars added by subsequent owners improved the service somewhat. Eventually a competitor became active on the Oregon side of the river.[2]

In 1862 the Oregon Steam Navigation Company gained control of the portage roads, mules, and cars on the Oregon side. By adding ownership of portage facilities to their existing domination of boat traffic, the OSNC obtained a secure monopoly of activity on the river. A steam locomotive—the first in Oregon—and several cars replaced the mules. River travellers enjoyed an efficient and quick portage on five miles of steel rail. The OSNC

Portage railroad at Upper Cascades on Washington shore, 1867.





above, top: Chart of early survey for the Cascades Canal. above, bottom: Cascades Rapids.

located a similar operation, over twice as long, at Celilo Falls.[3] The Board of Engineers for the Pacific Coast knew of the monopoly enjoyed by Oregon Steam Navigation on the Columbia. Reporting in 1878, it stated that "The whole of the navigation of the Upper Columbia and Snake rivers is now in the hands of a single company . . . . The only way to throw the entire river open to competitive navigation will be by the construction of a canal at The Dalles as well as at the Cascades."[4]

During 1876, Major Wilson received permission to hire an engineer expert in canal work; and after an extensive nationwide search, he selected Channing M. Bolton to supervise the planning and construction of the Cascades Canal. Bolton had had 17 years of experience on major engineering projects in the eastern United States and came highly

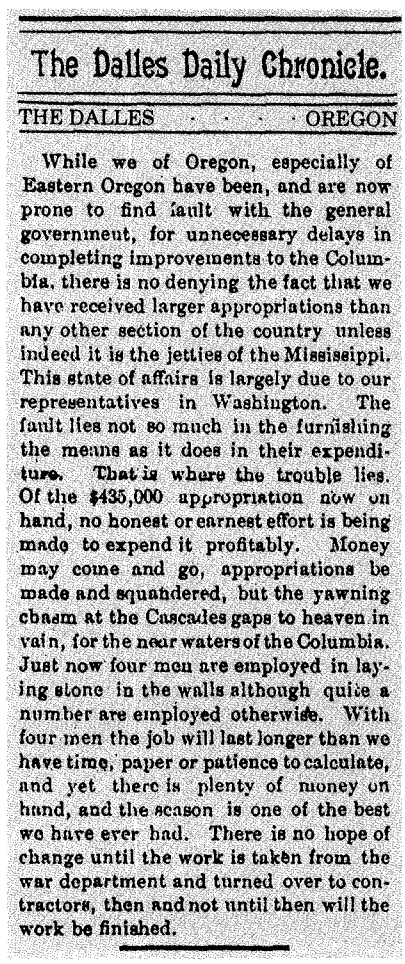
recommended.[5] After arriving in the fall of 1876, Assistant Engineer Bolton revised the preliminary plans developed by Major Michler, zealously conducting much new surveying and engineering work. By February 1877, Wilson presented his plan for the construction of a canal around the Cascades, at a cost of $1,188,680. As modified by the Board of Engineers for the Pacific Coast and the Chief of Engineers, the canal was to be 8 feet deep, 50 feet wide, and 7,200 feet long at low water, with two locks 8 by 70 by 300 feet at low water. A guard gate at the upper end of the canal would be used when repairs were necessary or during extreme high water periods.[6]

Since much of the machinery and equipment devised to operate the locks was of a unique hydraulic design, "entirely original with Mr. Bolton," he constructed a working model on a scale of one inch to four feet. This scale model showed "every detail of the crib-work and masonry, including locks, culverts, etc., and all the machinery for working the gates and valves and filling and emptying the locks."[7]

Complicated land condemnation proceedings necessary to acquire property for the Cascades Canal and Lock delayed work until November 1878.[8] Shortly before his transfer from the Portland Engineer Office in October 1878, Major Wilson awarded the contract for the initial excavation to a New York firm, Ball and Platt. Bids had been received from contractors throughout the nation. Unfortunately for the new Portland Engineer, Major George L. Gillespie, the first year of work on the canal was one long series of problems and frustrations.[9]

Only two months after work had commenced, A. H. Ball, senior partner and managing contractor, died from exposure while supervising construction. For several months thereafter little was accomplished for lack of competent supervisory personnel within the company and because of delays in receiving and assembling construction equipment. As construction limped along, primitive living conditions at the canal site worsened matters. The lack of nearby medical facilities made it difficult to provide proper care for injured workers. When a collapsing derrick "terribly" gashed one of the laborers across the face, Assistant Engineer Bolton reported that he used a sewing needle and ordinary silk thread to close the man's cut.

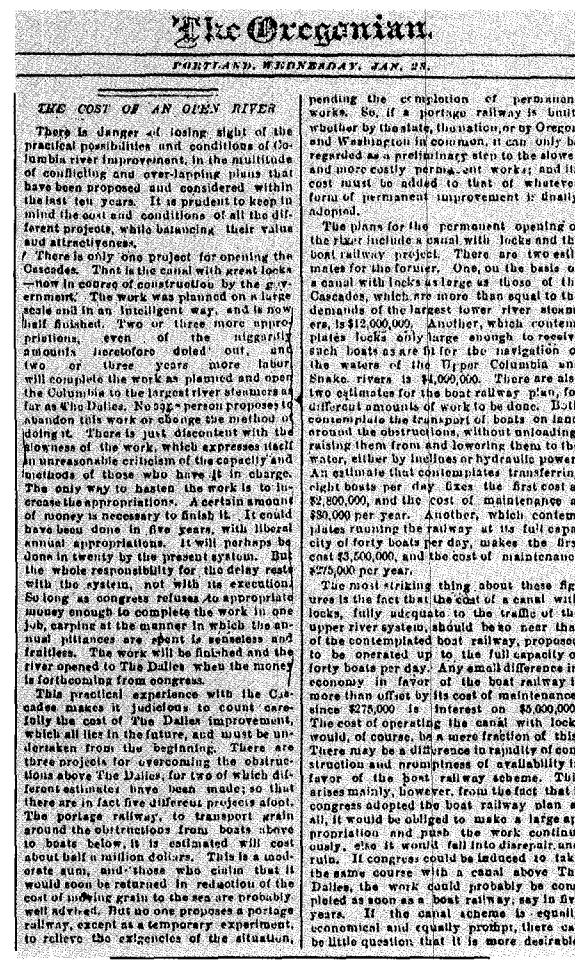
Major Gillespie found himself caught in the middle of a legal squabble between the surviving partner's legal representative and Ball's heirs. The work force, never adequate according to Gillespie, tried to take advantage of the situation. They struck for higher pay



The Dalles Daily Chronicle.

THE DALLES . . . . OREGON

While we of Oregon, especially of Eastern Oregon have been, and are now prone to find fault with the general government, for unnecessary delays in completing improvements to the Columbia, there is no denying the fact that we have received larger appropriations than any other section of the country unless indeed it is the jetties of the Mississippi. This state of affairs is largely due to our representatives in Washington. The fault lies not so much in the furnishing the means as it does in their expenditure. That is where the trouble lies. Of the $435,000 appropriation now on hand, no honest or earnest effort is being made to expend it profitably. Money may come and go, appropriations be made and squandered, but the yawning chasm at the Cascades gaps to heaven in vain, for the near waters of the Columbia. Just now four men are employed in laying stone in the walls although quite a number are employed otherwise. With four men the job will last longer than we have time, paper or patience to calculate, and yet there is plenty of money on hand, and the season is one of the best we have ever had. There is no hope of change until the work is taken from the war department and turned over to contractors, then and not until then will the work be finished.



The Oregonian.

PORTLAND, WEDNESDAY, JAN. 29.

THE COST OF AN OPEN RIVER

There is danger of losing sight of the practical possibilities and conditions of Columbia river improvement, in the multitude of conflicting and over-lapping plans that have been proposed and considered within the last ten years. It is prudent to keep in mind the cost and conditions of all the different projects, while balancing their value and attractiveness.

There is only one project for opening the Cascades. That is the canal with great locks—now in course of construction by the government. The work was planned on a large scale and in an intelligent way, and is now half finished. Two or three more appropriations, even of the niggardly amounts heretofore doled out, and two or three years more labor will complete the work as planned and open the Columbia to the largest river steamers as far as The Dalles. No sane person proposes to abandon this work or change the method of doing it. There is just discontent with the slowness of the work, which expresses itself in unreasonable criticism of the capacity and methods of those who have it in charge. The only way to hasten the work is to increase the appropriations. A certain amount of money is necessary to finish it. It could have been done in five years, with liberal annual appropriations. It will perhaps be done in twenty by the present system. But the whole responsibility for the delay rests with the system, not with its execution. So long as congress refuses to appropriate money enough to complete the work in one job, carping at the manner in which the annual pittances are spent is senseless and fruitless. The work will be finished and the river opened to The Dalles when the money is forthcoming from congress.

This practical experience with the Cascades makes it judicious to count carefully the cost of The Dalles improvement, which all lies in the future, and must be undertaken from the beginning. There are three projects for overcoming the obstructions above The Dalles, for two of which different estimates have been made; so that there are in fact five different projects afoot. The portage railway, to transport grain around the obstructions from boats above to boats below, it is estimated will cost about half a million dollars. This is a moderate sum, and those who claim that it would soon be returned in reduction of the cost of moving grain to the sea are probably well advised. But no one proposes a portage railway, except as a temporary experiment, to relieve the exigencies of the situation, pending the completion of permanent works. So, if a portage railway is built, whether by the state, the nation, or by Oregon and Washington in common, it can only be regarded as a preliminary step to the slower and more costly permanent works; and its cost must be added to that of whatever form of permanent improvement is finally adopted.

The plans for the permanent opening of the river include a canal with locks and the boat railway project. There are two estimates for the former. One, on the basis of a canal with locks as large as those of the Cascades, which are more than equal to the demands of the largest lower river steamers, is $12,000,000. Another, which contemplates locks only large enough to receive such boats as are fit for the navigation of the waters of the Upper Columbia and Snake rivers is $4,000,000. There are also two estimates for the boat railway plan, for different amounts of work to be done. Both contemplate the transport of boats on land around the obstructions, without unloading, raising them from and lowering them to the water, either by inclines or hydraulic power. An estimate that contemplates transferring eight boats per day fixes the first cost at $2,800,000, and the cost of maintenance at $80,000 per year. Another, which contemplates running the railway at its full capacity of forty boats per day, makes the first cost $3,500,000, and the cost of maintenance $275,000 per year.

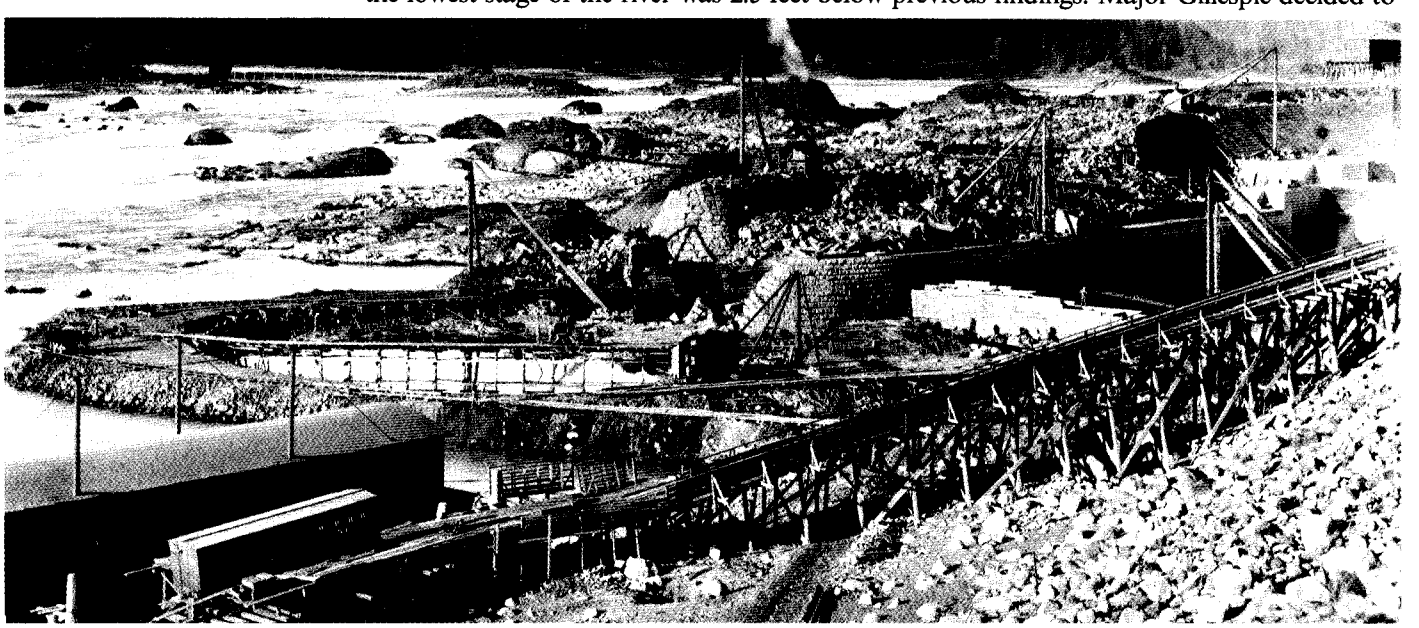
The most striking thing about these figures is the fact that the cost of a canal with locks, fully adequate to the traffic of the upper river system, should be so near that of the contemplated boat railway, proposed to be operated up to the full capacity of forty boats per day. Any small difference in economy in favor of the boat railway is more than offset by its cost of maintenance, since $275,000 is interest on $5,000,000. The cost of operating the canal with locks would, of course, be a mere fraction of this. There may be a difference to rapidity of construction and promptness of availability in favor of the boat railway scheme. This arises mainly, however, from the fact that if congress adopted the boat railway plan at all, it would be obliged to make a large appropriation and push the work continuously, else it would fall into disrepair and ruin. If congress could be induced to take the same course with a canal above The Dalles, the work could probably be completed as soon as a boat railway, say in five years. If the canal scheme is equally economical and equally prompt, there can be little question that it is more desirable.

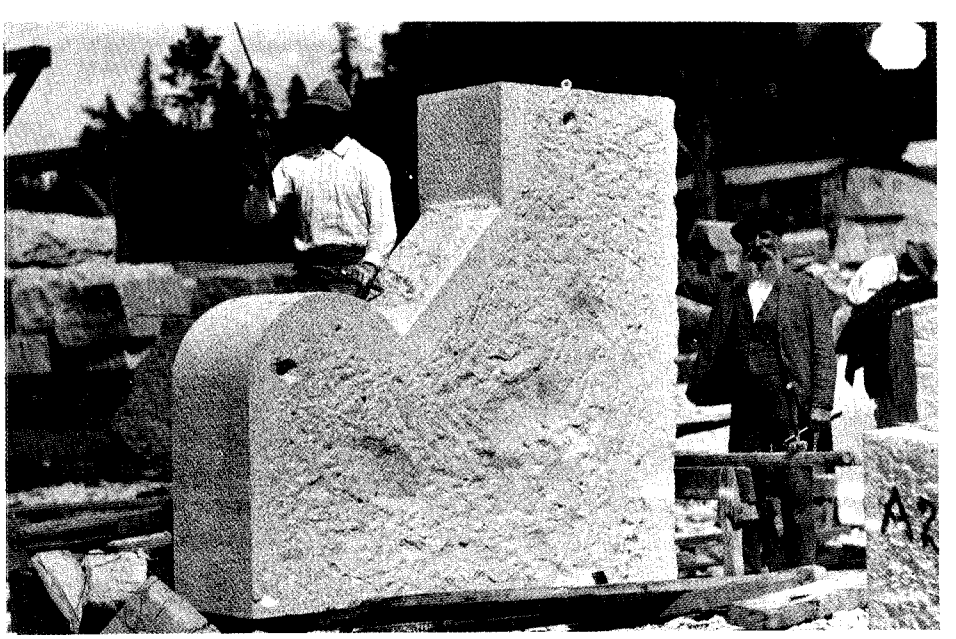
right: Newspaper article from The Dalles Daily Chronicle, *far right: Newspaper article from* The Oregonian *concerning the construction of Cascades Canal.*

and complained about the use of Chinese labor on the project. Actually, if anyone had grounds for complaint it was the Chinese; for they were paid 85 cents a day while white laborers earned $1.75. Major Gillespie solved most of the labor problems by paying the workers the same as if they were government employees out of the funds due the contractor. He used the same procedure in the purchase of materials. In addition, heavy rains and high water plagued the excavation work throughout the winter and spring; rainfall for the period between February and June totaled 57.28 inches. Then, to top it off, his chief assistant on the canal, Bolton, resigned in May 1879.

Based on Gillespie's repeated complaints that the contractor was not effectively prosecuting the work, the Chief of Engineers ordered the contract abrogated on 12 November 1879. Even that did not still the controversy between Gillespie and the contractor, who refused to accept the contract settlement offered in December. The contractor argued that his plant and materials were worth more than Gillespie would allow for them and appealed the terms of the settlement to the Secretary of War, who ultimately accepted Gillespie's findings and disallowed the claim on 3 July 1884.[10] As a result of this experience, most of the major work on the canal and locks was done by hired labor with materials purchased by bid on the open market, under the direct supervision of civilian assistant engineers or by officers of the Corps. Contracts were let only for specific tasks such as wharf construction or rock removal; general responsibility stayed with the Corps of Engineers.

In 1879 and again in 1880, during a review of the initial plans, Gillespie discovered that the lowest stage of the river was 2.5 feet below previous findings. Major Gillespie decided to



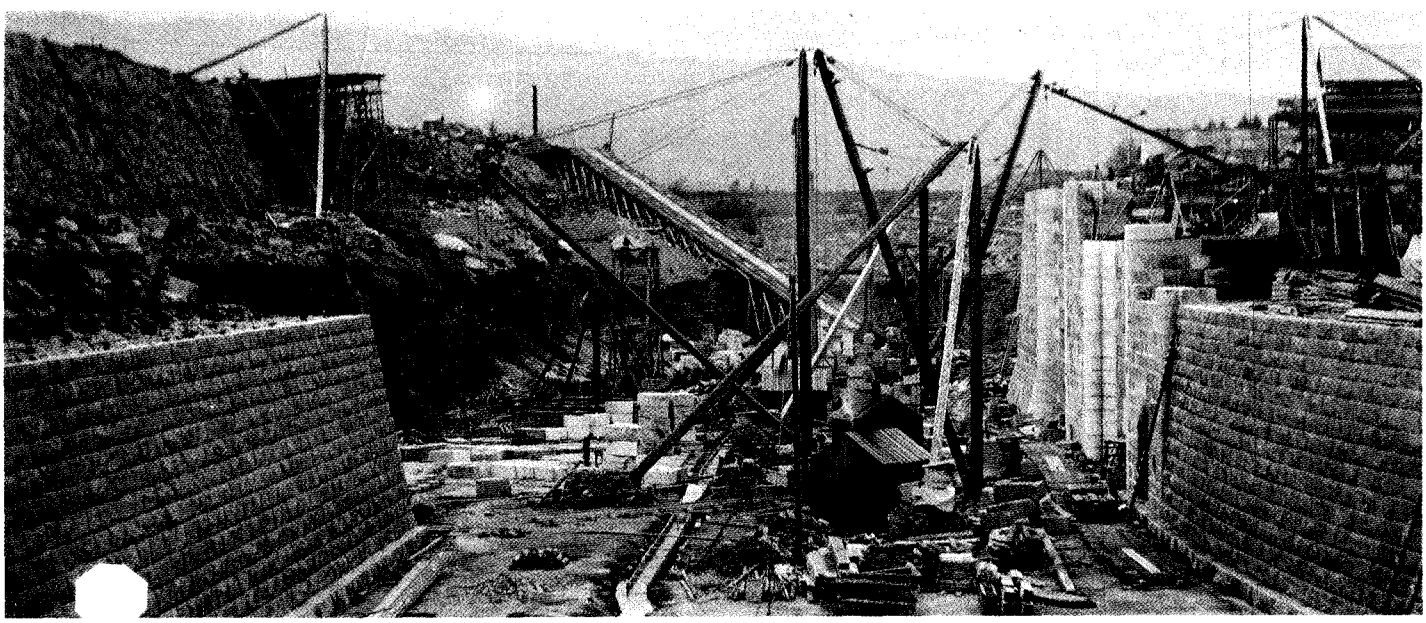


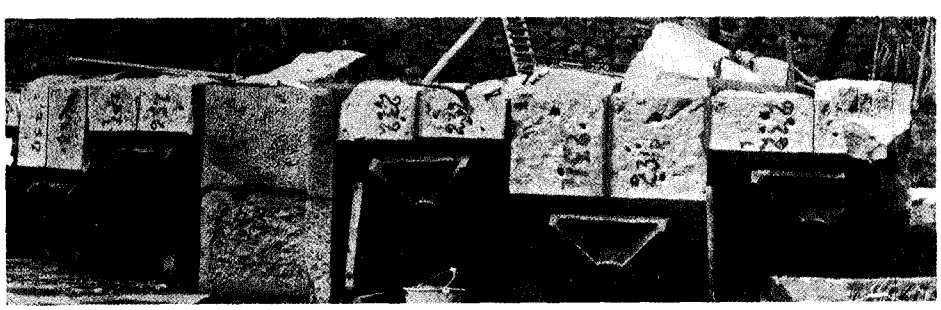
above: Overview of Cascades Canal construction. right: hand work of stone masons for canal construction.

halt work temporarily on the canal excavation while the reefs at the lower approach to the canal were removed and the exact low-water level established. A Board of Engineers agreed with his choice, fearing that "If the low-water at the foot of the locks be assumed on the data that we now have, . . . it is . . . probable that, when the reefs below are removed, and the low-water level at the foot of the canal lowered, the locks will fail to serve fully the purpose for which they have been projected."[11]

Other Boards of Engineers adopted numerous modifications to the original plans over the subsequent years of construction. Instead of two locks with a total lift of 26 feet, there was to be one lock, 90 feet wide and 462 feet long with a lift of 24 feet. The width of the entire canal was increased to at least 90 feet at all points, but with the lower and upper entrances eventually widened to 140 and 250 feet, respectively. The lock was designed to accommodate vessels to a stage of 20 feet above low water. The depth above low water was later increased, just before opening, to 36 feet. When finally completed, however, the canal had the ultimate capacity to handle traffic at any stage of the river up to 42 feet above low water. This capability resulted from a project modification in 1894 which allowed for the utilization of that part of the canal between the upper gates of the lock and the upper guard gate as a second lock by putting in a concrete floor and side walls. In 1886, the Chief of Engineers approved a proposal to enlarge the gate span to the same 90-foot width as the lock and to build the gates of steel rather than wood. The final addition, a moveable wall-gate device above the upper lock gates, insured against failure of the main lock. It was rarely used. Lieutenants Edward Burr and Harry Taylor produced most of the final design work for the project.[12] Lieutenant Taylor later went on to become Portland District Engineer and ultimately Chief of Engineers.

As noted above, work slowed at the canal lock site in 1881 to concentrate on improving the river approaches below the canal. The altered plans now meant that the depth of the canal would actually exceed the river at several points. This situation required the removal of great quantities of rock below the canal in order for ships to take full advantage of the canal's depth. This involved dangerous, arduous work in which seven workers lost their lives. Again, after initial unsatisfactory work by contractors, the Corps completed the river improvements by hired labor under its own supervision. The approach work consumed five years, and the original project cost estimate tripled to over $3,623,000. Full work resumed at the canal site proper in 1886, and ten years were necessary to bring the project to



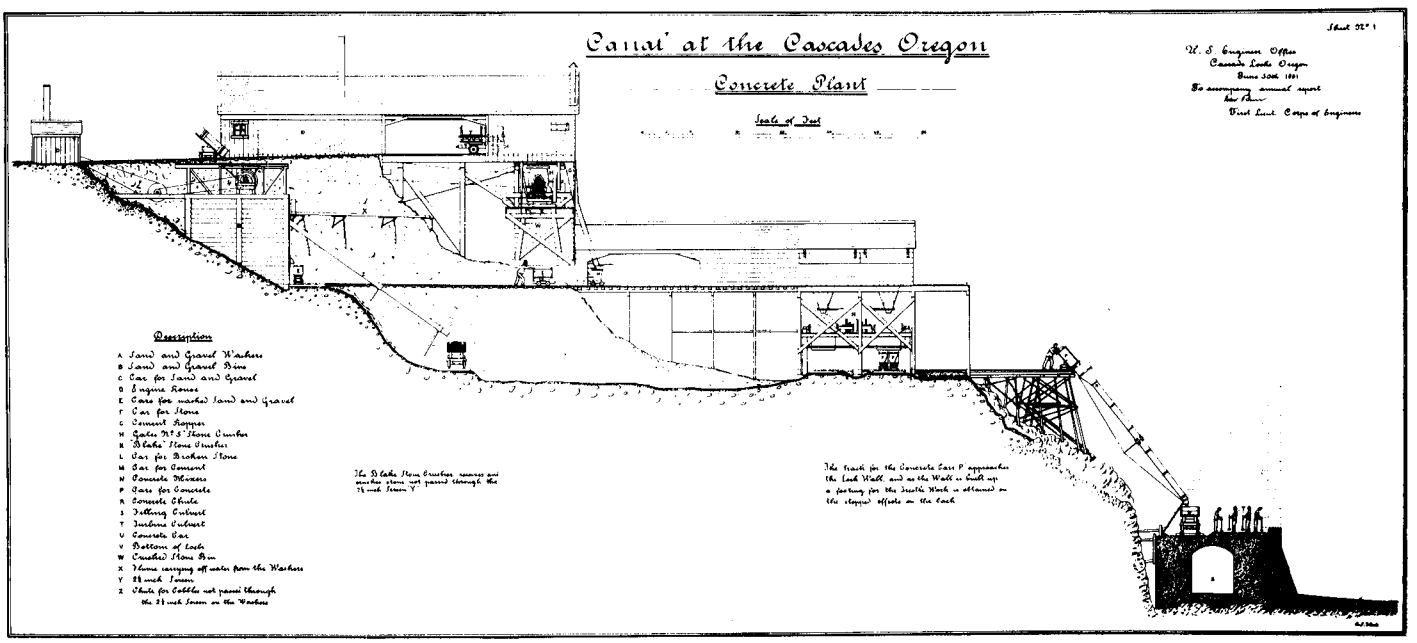


above: View of canal construction as walls take shape, right: Hand-carved stones, individually numbered to indicate placement.

the stage where the canal could be opened to traffic. To assist river shippers until the canal opened, the Corps allowed the state to build and operate a portage railroad across the canal grounds after 1891.[13]

Even before the canal opened, local lore had it that only the early settlers of the area could remember when work had begun. In addition to the great difficulty of the undertaking, until 1886 much time was consumed in unavoidable delays or on work not originally planned. Revisions of the project—formulated to improve benefits to navigation and taking into account engineering difficulties not originally anticipated—greatly increased the amount of work done. Several of the contractors did not perform their agreements satisfactorily. Funding difficulties stemming from Congressional retrenchment and work on other costly projects elsewhere in Oregon at the time took their toll. Finally, troublesome work conditions greatly added to costs and consumed valuable time. Captain Philip M. Price, resident engineer in 1883, reported that because of high water no work could be done from the middle of May to the middle of August. Unfortunately, this was the driest and most favorable work-period at the site; during the remainder of the year, when low water permitted work in the canal, excessive rainfall and frequent snowstorms hampered the laborers. During the wet season, the men had to work in heavy oil-skin coats and awkward rubber boots. Price explained that men so incumbered could produce only about half of their normal work. He noted that the canal site was "exceedingly rough and broken, covered with a mass of boulders, varying from one-half to one hundred tons and more in weight." Once lifted by derricks, tramways with mule-drawn cars removed the excavated material.

below: Profile of the concrete plant used for Cascades Canal construction.

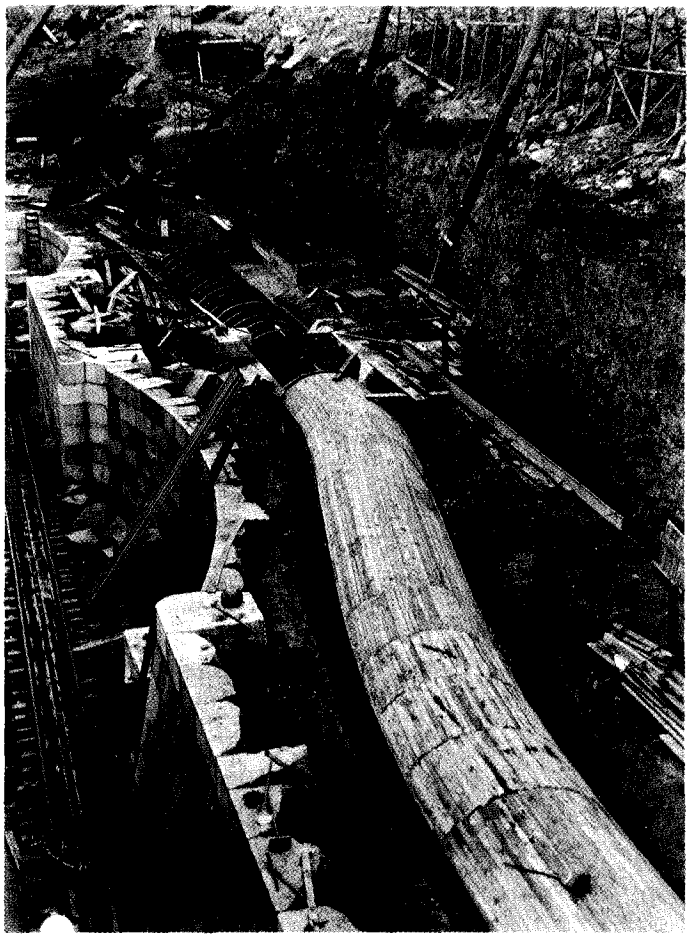


The vast quantities of water and mud prevented the use of wagons or carts. Finally, Price wrote,

> *The great rise of water during floods causes a very large annual expense for the moving and protection of this heavy plant and other property. It must be all either moved or effectually protected at the beginning of the flood, and must be again moved into position and put in readiness for work on the subsidence of the water. The annual protection and moving of property and heavy plant consumes a large percentage of the small appropriations hitherto made, and counts nothing towards the completion of the canal.*[14]

By the late 1880s, local public pressure to complete the Cascades Canal reached a peak. The annual meetings of the Columbia Waterway Convention passed resolutions imploring Congress to appropriate funds to complete quickly the Cascade Canal and to begin work on the obstruction at The Dalles. Senator John H. Mitchell of Oregon delivered speeches demanding that Congress act and newspaper editors issued clarion calls for larger appropriations and more energetic prosecution of construction.[15]

A shortage of funds and transfers of responsibility for the project caused a complete suspension of work for several months in 1886, in 1888, and again in 1890. In obvious frustration, Major Thomas Handbury wrote in his annual report for 1888 that small appropriations parcelled out over twelve years had caused nothing but problems. "At this rate," he observed, "it will require perhaps twenty-four years more before any benefit to commerce will result from this work, or the country receive the least remuneration for the money expended." Echoing the local folk wisdom, he noted that "a generation will have



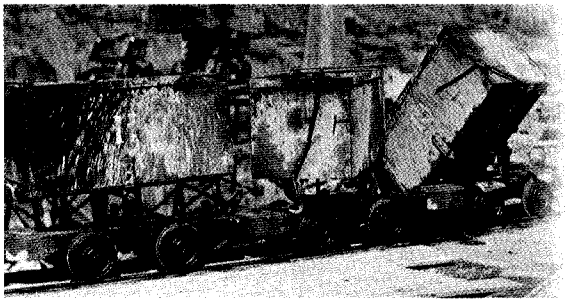
Water supply channel formed in the canal wall as construction progressed.

been born and gone to its grave between the beginning and the ending of an enterprise which a healthy syndicate would have prosecuted to completion within six years at farthest after commencement, and been in the enjoyment the balance of time of a liberal income from the money invested."[16] Not fully cognizant of numerous difficulties encountered by the Corps of Engineers, the public and politicians accused the Corps of mismanaging the project. In particular, public outrage centered on the use of hired labor under Corps supervision. Congressman Binger Hermann and various Oregon newspapers asserted that private enterprise could do the work faster and more economically under the contract system, forgetting the original unsatisfactory results of contract work for excavation and river improvements.

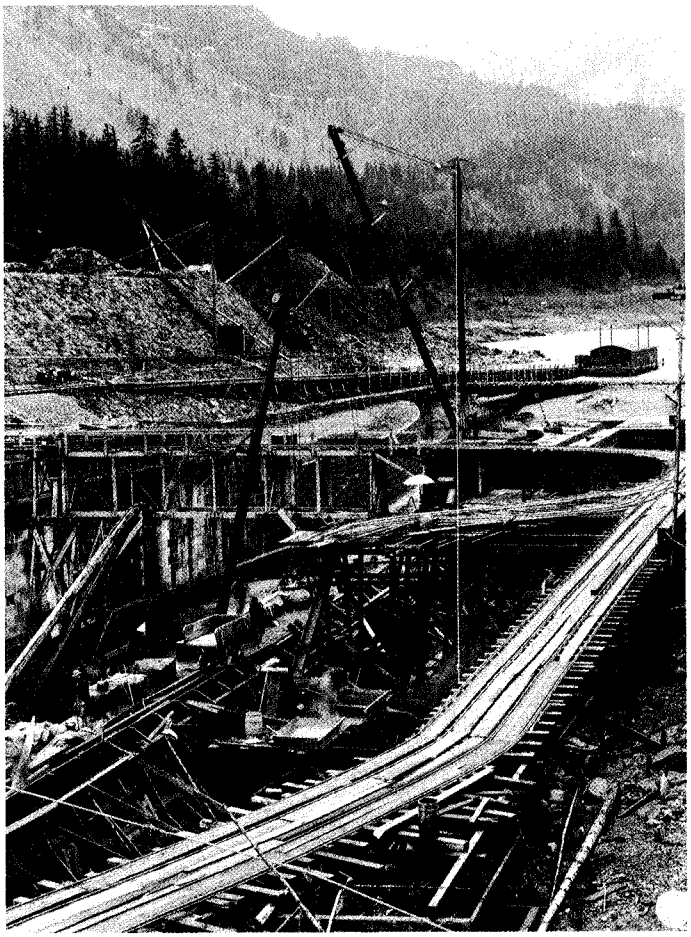
In a lengthy defense of the Corps' management of the Cascade Canal project, Major Handbury forcefully presented his view. He asserted that the Government was "honestly and economically" building the canal with its own plant and work force. He rhetorically asked: "Shall these officers, whose ability, zeal, and integrity can not be doubted, be pushed aside and the management of this work be turned over to an individual whose only merit may be that he thinks that he can do it cheaper and is willing to give bonds?" Handbury had little regard for contractors, as he felt dishonest ones would seize every opportunity "for increasing his profits by slighting his work and using poor and cheap material," while "even the honest one will be often sorely tempted to straining a point here and there in spite of every precaution that can be taken." In sum, Handbury stated

> *I am of the opinion that it would be detrimental to the work and to the interests of the Government to attempt its completion by contract; and urgently recommend that the full amounts that can be profitably expended in each year as recommended by the Chief of Engineers be made available, and that the work be prosecuted by hired labor with the plant belonging to the Government.*[17]

Congress rejected Handbury's advice. The River and Harbor Act of 13 July 1892 specified that the appropriation for the Cascade Canal be expended by a continuing contract. It did materially increase appropriations, however, voting $326,250 in 1892 and $1,239,653 in 1893. Specifications for completing the entire project were put to bid and the J. G. & I. N. Day Company of San Francisco received the contract on January 31, 1893. The Government plant at the canal site was turned over to the contractor. Handbury still had his doubts about letting a private builder finish the project; but he grudgingly told a

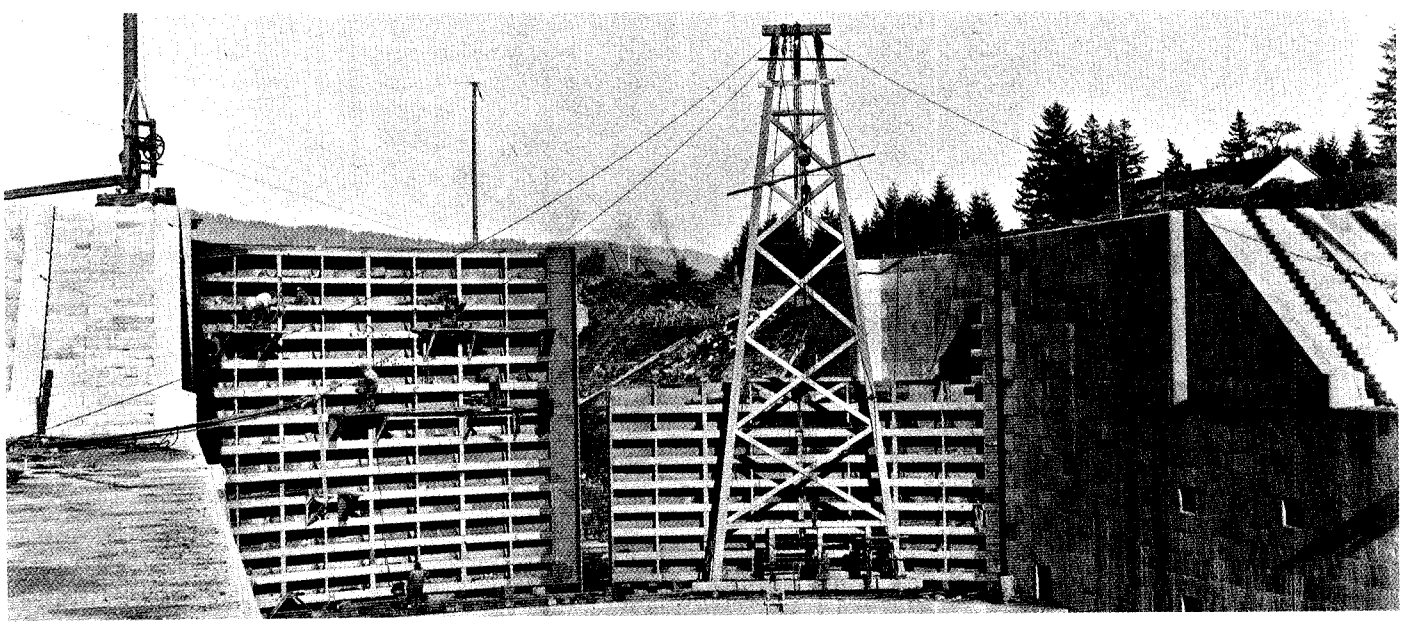


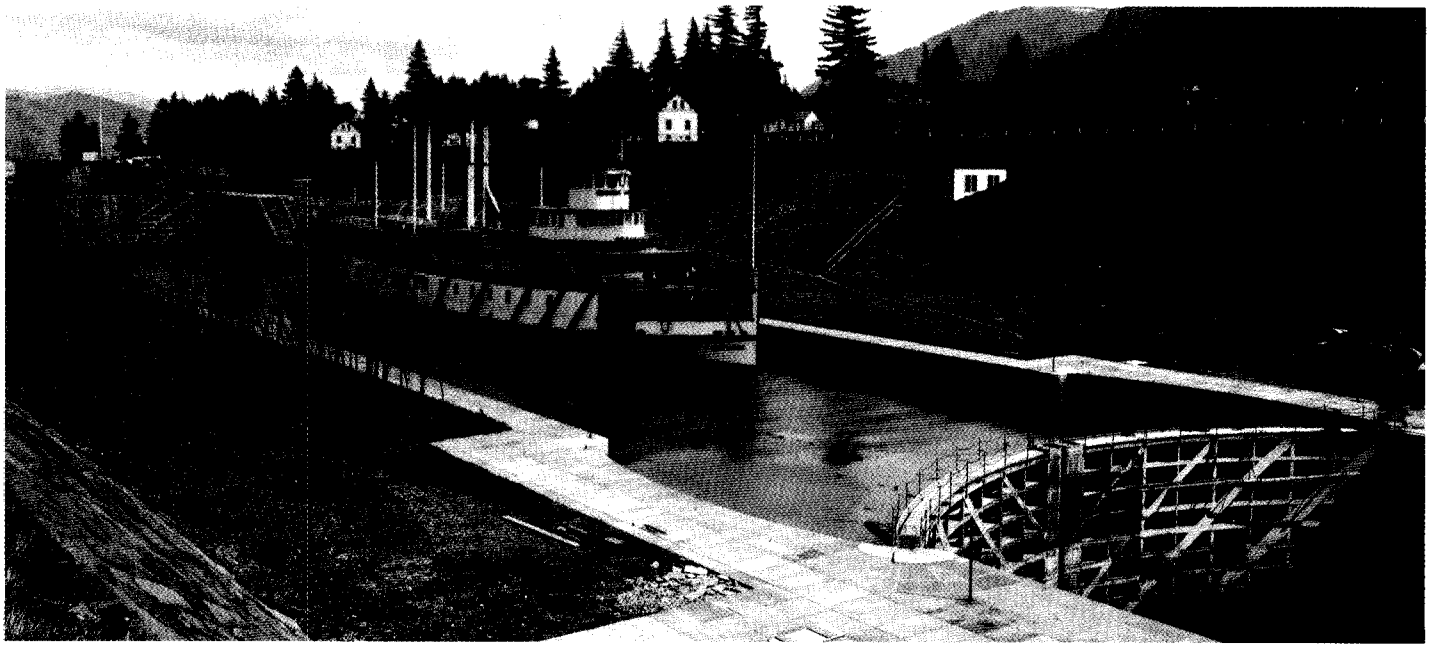
Tilting dump cars used for transporting material from concrete plant to canal construction site.



Tramway system for transporting material to construction area.

below: Work on the canal gates.





above: River boat passing through Cascades Canal.

fellow engineer officer that "I have done all that I can to keep the matter straight, and will willingly carry out all orders that I receive, from higher authority, even though they are not always in accordance with my judgment. The responsibility is theirs, not mine."[18]

Unfavorable weather and contractor delays necessitated three contract extensions of a year each. The record flood of 1894 damaged the lower end of the canal and required such repairs as raising the heights of the canal walls and strengthening the revetment work. In addition, District Engineer Major James Post and a Board of Engineers concurred in recommending the creation a second lock adjoining the first by constructing walls between the upper lock gate and the upper guard gate so that the canal would be navigable to all stages up to 42 feet above low water. The proposed modifications added $318,573 to the ultimate cost of the project and were not completed until 1914. Despite the delays and modifications, the large appropriations enabled the Corps to open the unfinished canal in 1896. To that date, $3,793,496.94 had been expended on the project.[19]

Oregonians greeted the opening of the canal with great excitement and celebration. On 5 November 1896, several hundred excursionists passed through the locks on steamboats to view the great work at close quarters. The steamer *Sarah Dixon* had a small cannon bolted to her deck, and at appropriate intervals she would fire a booming salute.[20] And well, she might; for the Cascades Canal's construction had been a formidable task, requiring many novel engineering details. A Board of Engineers correctly stated in 1894 that the work had neither counterpart nor precedent. Looking back, they could see that

> *when the work of improvement began no records or observations existed in giving information with reference to the physics and hydraulics of the Columbia River . . . ; nothing was known as to the phenomena accompanying the various phases of floods. No record existed of the heights of water at extreme stages.*[21]

The engineers in charge had gained such knowledge slowly, though painstaking trial and error methods.

The benefits to commerce were immediate. In 1895, the last year of its operation, the state portage railway had moved 8,122 tons of freight; but the canal eventually carried many times that amount annually at no charge to any shipper, commercial or otherwise. The value of freight through the canal in one year alone equalled the entire cost of constructing the project. In addition, the canal restored a competitive balance to freighting. The Union Pacific Railroad, which had replaced the Oregon Steam Navigation Company as the sole carrier along the Columbia, now had competition from river shippers. By making the shipment of bulk materials on the river more economical, the canal helped moderate railroad rates.

Major Gillespie

For almost three years, from October 1878 until July 1881, Major George L. Gillespie served as engineer officer in Portland. Also a Congressional Medal of Honor recipient for gallantry during the Civil War, Gillespie later served as a Division Engineer in New England and as Chief of Engineers from May 1901 to January 1904. It was under his supervision that the original plans for the Cascade Canal were altered and work was shifted to improve the bed of the river below the site of the canal. Major Gillespie was unable, however, to devote his sole attention to the problems of the Cascade Canal. On-going and newly initiated projects within the District also required his direction.

Work on the upper Columbia and Willamette projects continued. In his Annual Report for 1879, Major Gillespie expressed his admiration for the Willamette River Valley because of its fertility and its thriving, industrious population.[22] In 1878 he obtained authority to clear all obstructions in the Willamette River to Eugene, and for annual operations thereafter to keep it clear. To accomplish this goal, the district built a few small dams, removed hundreds of snags, rocks and other obstructions and scraped bars at low water. In 1880, Gillespie received authority to extend this work to the lower Yamhill River. These activities constituted the main type of work done on the Willamette throughout the 1880s and marked no departure from the approach devised by his predecessor, Major Wilson.[23]

The most important work performed during Major Gillespie's tenure, however, was on the Oregon coast. A survey under Major Wilson at Coos Bay in 1878 had shown that shifting sands and unpredictable tides obstructed navigation at this locality. Major Wilson made a detailed chart of the entrance and submitted plans calling for two jetties or training walls 8,000 and 5,000 feet long to cost $972,000; he added that there was a possibility that only the south wall would be needed at a cost of $600,000. The Board of Engineers accepted his findings, and ruled that only the south wall would be built. The jetty was to extend southwest from Fossil Point on the east side of the bay opposite the entrance, directing the ebb current through the channel so as to prevent sand accretion and the eddy condition inside the entrance.[24]

When work actually got underway late in 1879, Major Gillespie's military assistant found a flaw in Wilson's original plan for Coos Bay. Lieutenant A. H. Payson, the Corps

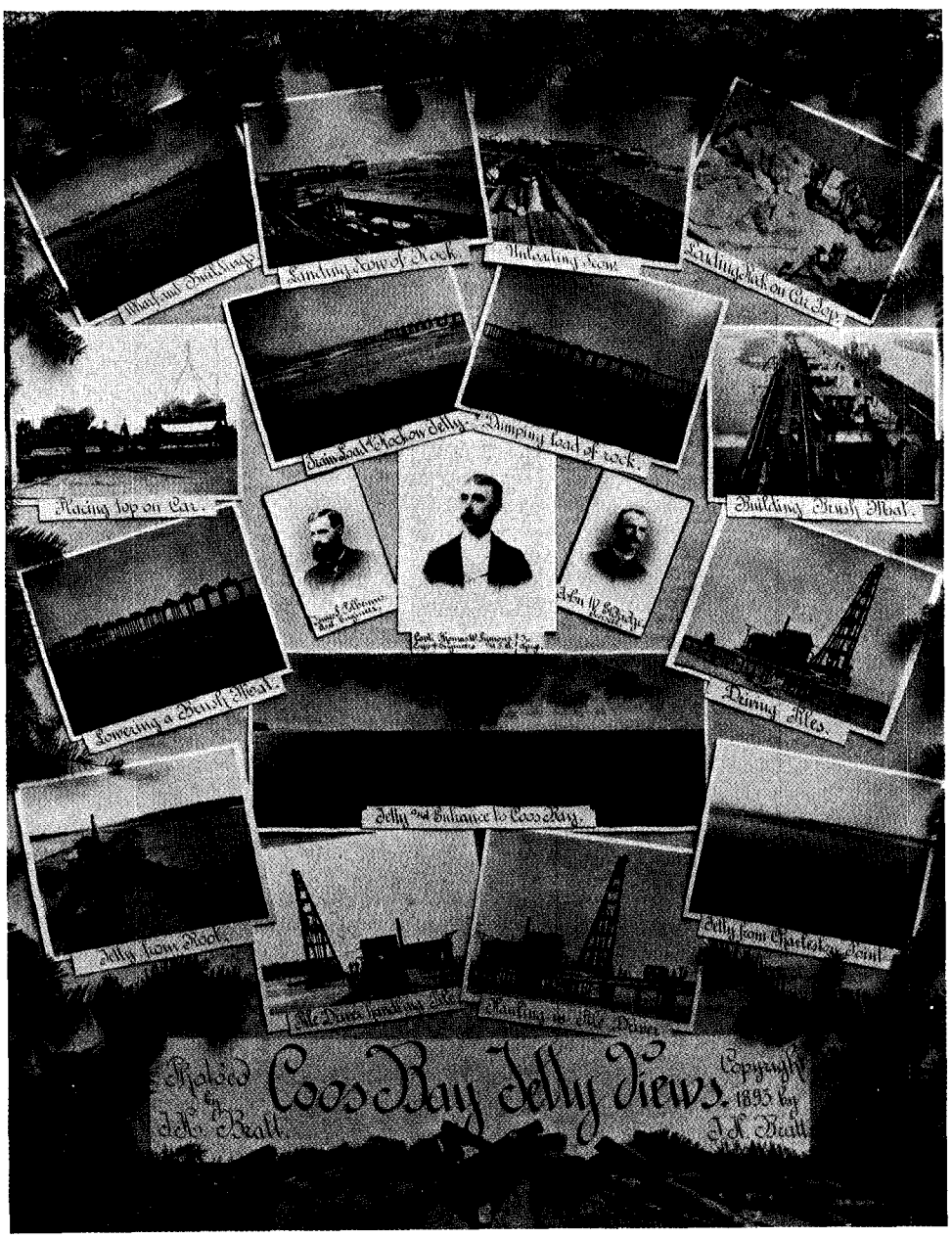
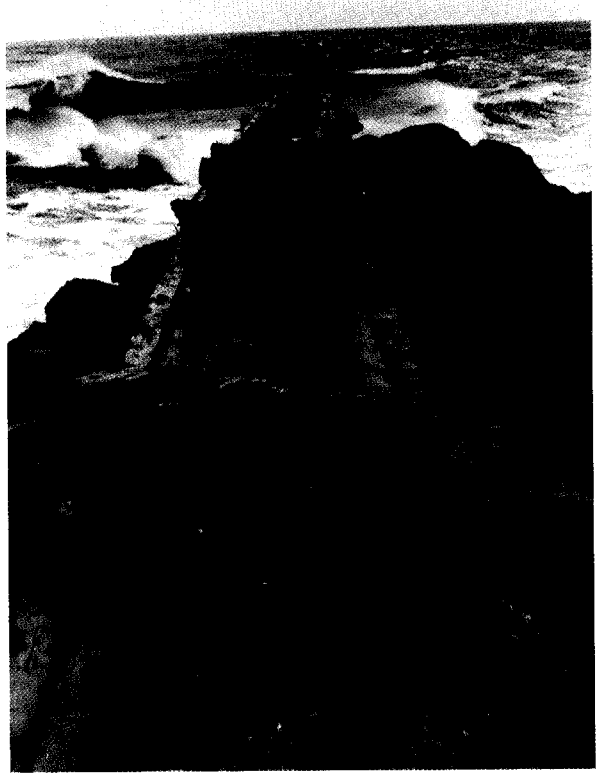


Photo display done by J.H. Bratt in 1893 celebrating the Corps early Coos Bay jetty work.

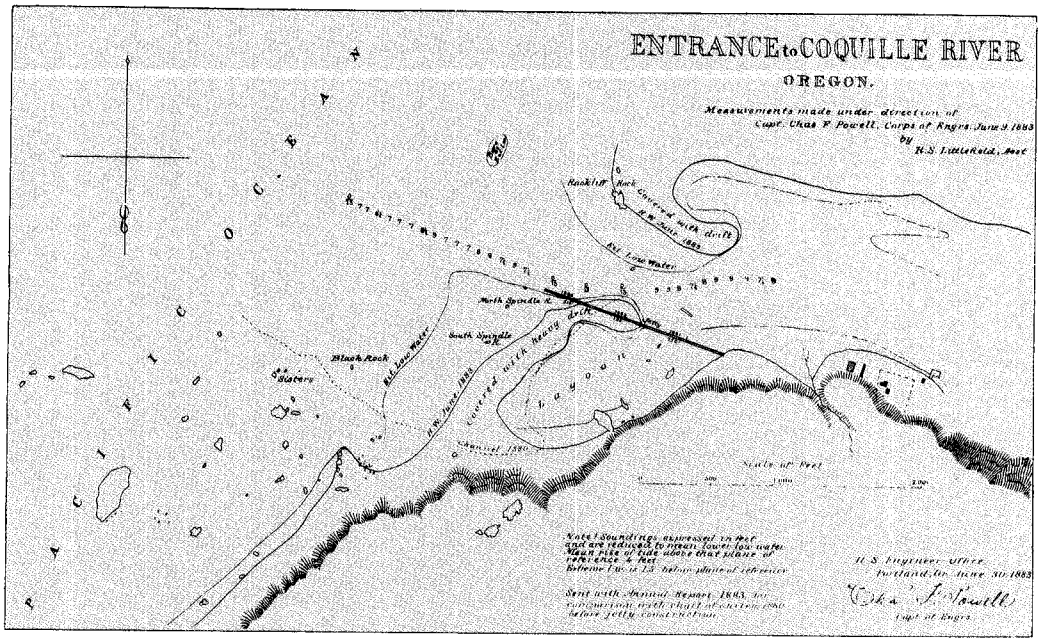
supervisor of the work, decided that the floor of the entrance was too rocky for pile driving, so another method was needed to keep the jetty stones in their place. Almost as an experiment, they decided to build large timber cribs, fill them with heavy stone, and lower them into place in the water. This became known as the "crib" method. The cribs were 50 feet long, 10 feet high, and 26 feet wide. Because of the difficulty in placing the huge structures in the water with the crude means then at hand, together with the small amounts appropriated ($40,000 for the first year), progress was very slow. Only 450 feet of cribbing had been set in place by August 1880.[25]

In his 1881 request for additional funds for work at Coos Bay, Major Gillespie emphasized the desirability of completing the project. Coos Bay was the only regular steamer and lumber port south of the Columbia. He thought it showed great potential for "a very important trade, not only with San Francisco, but with all the islands of the Pacific which give a demand for coal and lumber, and the various kinds of excellent timber."[26] Work on the project continued throughout the 1880s, but the crib method of jetty construction became too dangerous and costly because of changes in the current. In its place, Major Gillespie ordered a return to the tramway-dumped stone process. Small appropriations and great damage to the jetty and tramway caused by rough seas slowed progress. Despite these difficulties, substantial benefits were realized by the stabilization of the channel as early as 1883. Trade and commerce grew rapidly at Coos Bay from the $468,000 valuation of shipped goods in 1877 to $1,992,903 in 1890. At the time of these earliest improvements, Coos Bay was the most important port on the Oregon Coast. Later works would help it to become the greatest lumber product export port in the world.[27]

Rocks and shifting sands caused difficulties at the mouth of the Coquille River. While completing a survey in the summer of 1878, Assistant Engineer Channing M. Bolton learned from a pilot at the Coquille that "the sands are so shifting that he cannot rely on information gained one day for the next, but has to make a thorough examination of the channel before each trip."[28] Major Wilson, in transmitting Bolton's report, urged that the timber, minerals, and agricultural abundance of that section justified improvement of the Coquille entrance.[29] Accordingly, Major Wilson requested $164,000 with which to build two training walls, 2,000 and 3,400 feet long, to run parallel to each other along the deepest section of the existing channel to deep water in the ocean. He hoped that "the increase of velocity due to the contraction of the channel will give sufficient scouring force to keep open



Violent wave action on jetty destroys tramway and displaces rock.



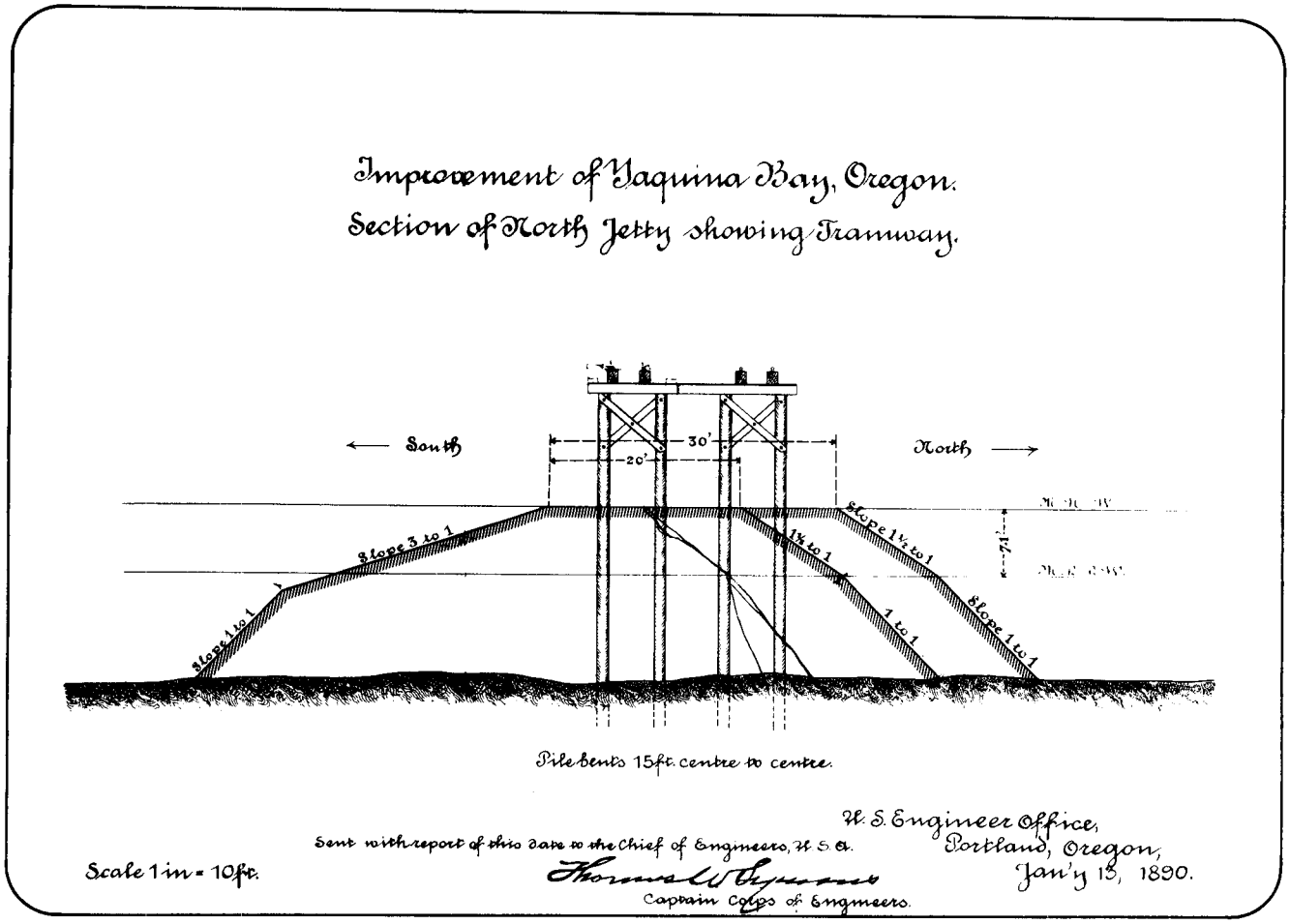
Captain Powell's 1883 chart of the Coquille River mouth.

a channel with a depth of 12 feet."[30] Work at the mouth of the Coquille proceeded under Major Gillespie in 1880 after revision of the original plan drawn up by Major Wilson.

The engineers thought that only one smaller jetty, instead of two large jetties, would be adequate to cut the bar and the spit at the entrance and to provide 15 feet of safe water at high tide. Because of the distance from the district office, Major Gillespie gave the resident engineer in charge discretion in the details of actual construction of the jetty, although Gillespie urged him not to sacrifice "strength to length." Work under Assistant Engineer R. S. Littlefield proceeded quickly when the cribs placed in the water for the foundation were reduced in size to 4 feet tall, 6 feet wide, and 30 feet long. A tramway built over this foundation transported stone from a quarry to the advancing jetty. Within two years 850 feet of the south jetty were laid, 5 feet wide at the top and 15 feet wide at the bottom, protruding 2 feet out of the water at low tide. When the appropriations for the Coquille project failed in 1883, Captain Charles Powell, Gillespie's successor as Portland Engineer, expressed disappointment, for he was quite proud of what had been accomplished so far. He wrote the editor of the Coos Bay newspaper that "for result and cost the improvement at the mouth of the Coquille will compare, most favorably with that of any other sea coast entrance." The following year funds were renewed, and by 1887 the jetty had been strengthened and extended to 1,625 feet.[31]

Major Gillespie started a third project on the coast at Yaquina Bay. For this formidable task, Gillespie sought out a seasoned engineer. After a thorough nation-wide search he hired James S. Polhemus, a civil engineer working for the Galveston Engineer Office. In 1873, Polhemus had won renown for his survey of the entire Texas coast. Hired in July 1880, Assistant Engineer Polhemus performed a survey in the fall of that year and drew up plans for a 2,500-foot jetty. He found the entrance to the large bay at the mouth of the Yaquina River, midway between Astoria and Coos Bay, limited to a seven-foot depth by a sand spit which extended from the south. Also hazardous were the reefs which ran parallel to the coast only a few thousand feet off-shore. Major Gilespie believed that creation of a 17-foot harbor depth would make the bay "a shipping port of great importance, not only for the products which are raised in the immediate vicinity, but for a great part of the Upper Willamette Valley, with which it is said that there will soon be a railroad connection."[32] The project, consisting of a jetty formed by timber cribs filled with stone or of brush mattress weighted with stone aligned to create a scouring current along the central channel, was approved in July 1880. Congress provided an initial appropriation of $40,000 to start work in the fall.[33]

The Yaquina work party encountered difficulties in starting the improvement. The isolated location of the bay forced Gillespie to purchase, either at Portland or San Francisco, and ship by special boat "all the various materials and implements of construction—iron, anchors, picks, chains, crowbars, oakum and etc." In addition, he reported that the only sawmill in the harbor was unable to supply suitable logs for construction. As a consequence, "considerable time was spent collecting logs before any lumber for scows or timber for the cribs could be obtained." As a result of these problems, Gillespie complained that "the initial preparation [was] very expensive," and "delayed—much beyond my patience—the time of beginning the jetty."[34]



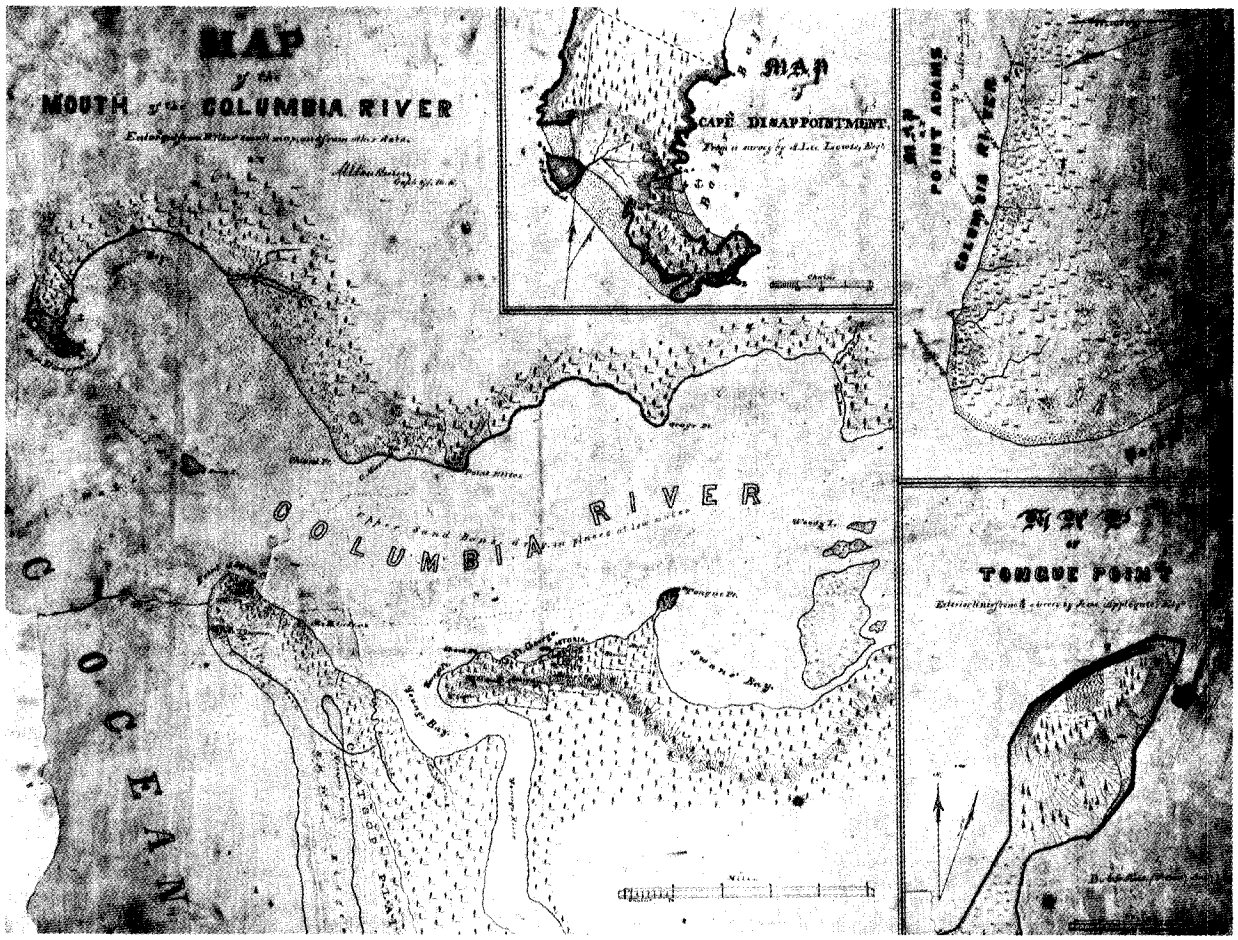
above: Section diagram of the Yaquina Bay north jetty.

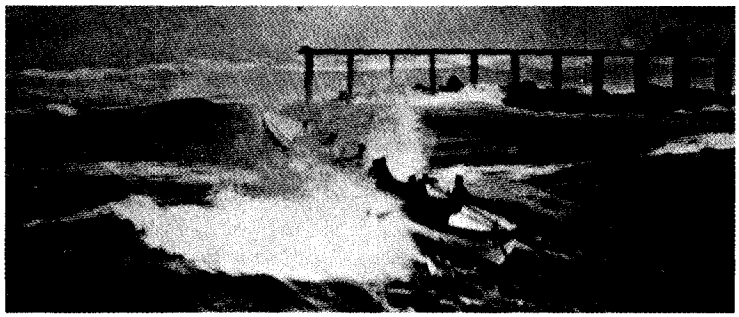
The entrance to the harbor was considered so dangerous that no tugboat captain was willing to hire out and assist in the work. A tug had to be purchased in San Francisco. The "exceedingly strong and variable" currents at Yaquina Bay presented the work party with "the greatest imaginable difficulty." The plan of placing stone and cribs from barges proved impractical, and Major Gillespie decided to build the jetty from the shore outward, carrying the stone out over a tramway 2,500 feet long. He admitted that "this plan necessitates the handling of the stone four times before it reaches its final place in the jetty, but I see no other way of accomplishing the desired end."[35] Assistant Engineer Polhemus used this method for the next seven years until 1888 when the project was modified.[36]

Major Gillespie also managed the first segment of the important project at the mouth of the Columbia River. Over the years, the bar at the mouth had gained a reputation for treachery. In its natural state, the tides and currents from the ocean, plus the current of the Columbia itself, could alter the entrance almost overnight. Charts dating back several decades showed that two channels existed at the mouth of the river. Neither of these two channels was deep enough or dependable enough for the volume of commerce and the size of ships which passed up and down the Columbia. Only desperate or foolish captains attempted the entrance without the aid of a pilot or tug. Even if the channel were quickly found, the depth which could be relied upon, 17 to 21 feet, left little to spare. Weather conditions and the tremendous sea on the bar often detained sailing vessels weeks and steamers days. The largest ships could enter only during a smooth sea at high tide.

In spite of these well-known conditions, Gillespie's predecessors played down the bar's dangers. Major Michler wrote in 1875 that "the bar cannot be considered any more dangerous than the entrance . . . into San Francisco Bay."[37] He believed that its disadvantages could be overcome by using pilots and avoiding storm crossings. Two years later, Major Wilson agreed that the Columbia bar had an "undeservedly bad reputation." "Properly buoyed," he stated, "it is no more dangerous than that at Sandy Hook, New York."[38] River users found such views unacceptable. As Major Gillespie noted in 1880, "the citizens of Astoria are anxious that some extensive work of improvement should be taken in hand to increase the depth of water over the bar."[39]

Responding to public pressure, Congress authorized in June 1878 a survey at the mouth of the Columbia to determine the nature and cost of permanent improvements. In 1880, after completion of preliminary surveys, Gillespie agreed with Wilson and Michler that





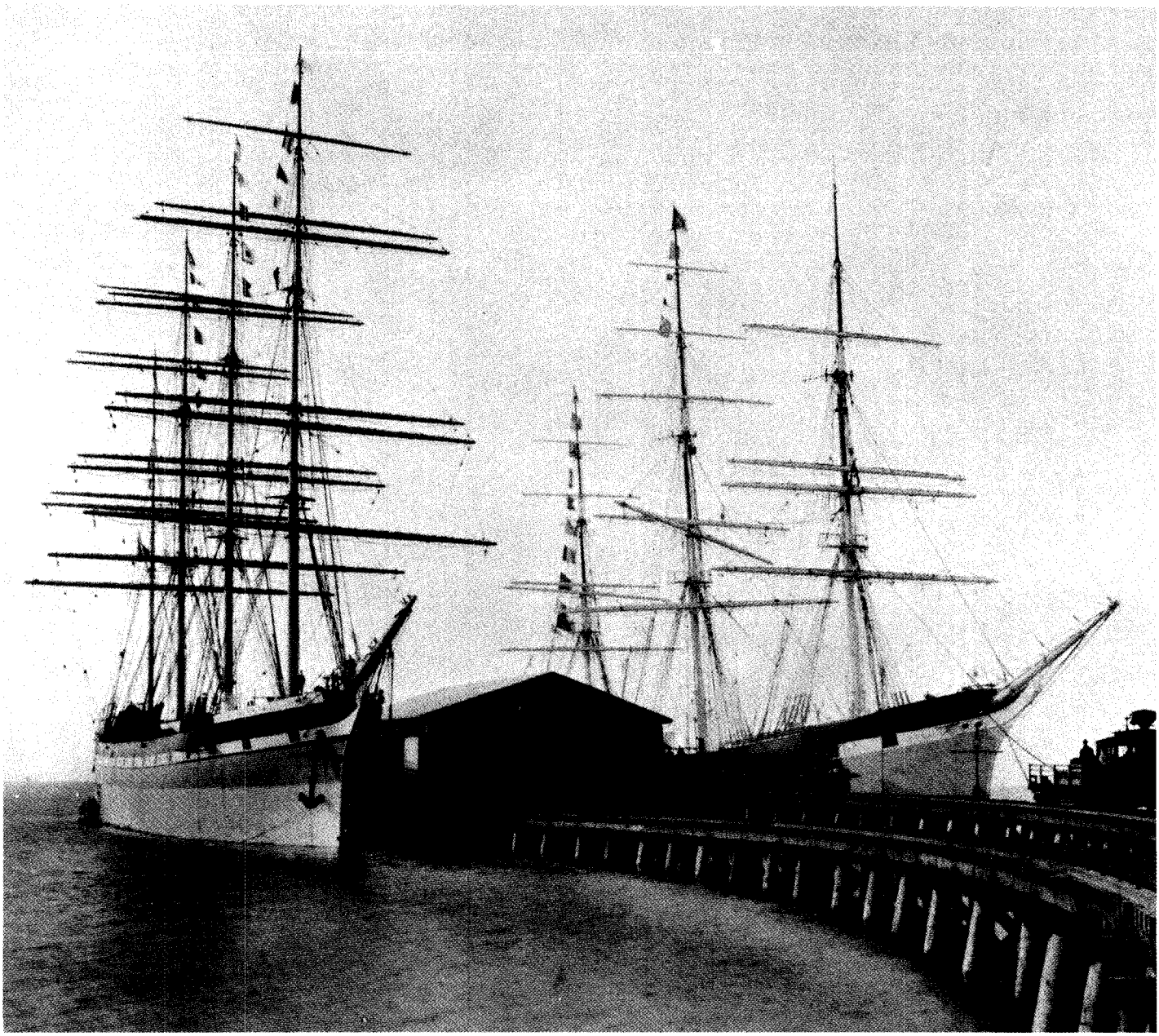
above: Early composit of Columbia River mouth surveys. right: Small boat crossing Columbia River bar before jetty completion, (note jetty construction in background).

the dangers of the bar "have been greatly and unjustly magnified . . . I know of no bar at the mouth of a great and mighty river which has a better record than that of the Columbia River."[40] However, he admitted that the bar could stand improvement. He allowed that "it is impossible to give an estimate of the extent to which commerce will be benefitted by this improvement." But he argued that

> *should an improvement be adopted for the harbor which will give an increased depth of water over the bar and enable vessels drawing 22 to 23 feet of water to cross without danger at all stages of the tide, the commerce of the whole of the northwest will be increased beyond the capabilities of any one to estimate at the present time.*[41]

Major Gillespie drew up several tentative plans for improvements. He fully recognized the magnitude of the problem, declaring in 1879 that "the building of breakwater in the open sea, to cover so wide a harbor entrance, and resting upon such an unstable foundation and exposed to such terrific seas, is an undertaking which any engineer may well hesitate to recommend and tremble to commence."[42] His first proposal, submitted in December 1879, called for a low-tide stone dike, extending from Point Adams for 10,000 feet along the east edge of Clatsop Spit. It would have a base of 166 feet, a top width of 25 feet, and cost $4,750,000. While admitting that it was possible "to make a training wall for the ebb waters by substituting for the stone dike a double or triple row of piles, and filling the spaces with fascines and stone," he did not recommend "such a temporary and experimental structure."[43]

After giving the matter further thought, Gillespie withdrew his initial project. He felt that the cost and time required to complete such a massive structure made it impracticable.



above: Sailing vessels in early Astoria harbor.

Instead, he proposed the very plan he had rejected the previous year. He now put forward an 8,000-foot pile dike, 20-feet across filled with stone and fascines. Built on the south side of the mouth, it would cost only $430,000. He was confident that if Congress appropriated the entire sum at once, the dike could be completed in a single season. Its function was to obtain a secure, deep channel by concentrating the current of the river and the tidal action of the sea. He predicted that the pile dike would prevent sand from drifting into the channel from the south, minimize the effect of stormy weather on the water, and allow vessels to enter the Columbia with little delay or cost.[44]

The Review Board for the Pacific Coast, unconvinced that any improvement was necessary at that time, rejected Gillespie's revised plan. The Board decided that the natural effects of tides and currents would open a channel adequate for present needs. Once again, citizens of the area found this conclusion unacceptable. For many years they had observed no beneficial effect of the tides or currents. Within two years, the Board of Review, reassembled by Congress, considered another, even larger plan for a jetty at the mouth of the Columbia. While this project was adopted after Major Gillespie had left Portland, he had accumulated much valuable information and proposed alternatives for dealing with the problem. When work on the jetty finally commenced, it proved the largest project undertaken by the Portland District until the 1930s.[45]